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East Europe Report

SCIENCE & TECHNOLOGY

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GERMAN DEMOCRATIC REPUBLIC

DELTA COMPUTER NETWORK TO BE EXPANDED

Cooperating Institutes

East Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Vol 21 No 5, May 84 pp 5-7

[Text] Dresden College Computer Centers' Cooperative Association

The Dresden College Computer Centers' Cooperative Association (KG-HRZD), founded in 1976, includes the ORZ/RZ/FRZ [organization and computer centers/computer centers/scientific and technical computer centers] of the
--Academy of Pedagogic Sciences
--Dresden Friedrich List Transportation College
--Dresden Engineering College
--Zittau Engineering College (since 1982)
--Dresden Carl Gustav Carus Medical Academy
--Dresden Technical University
and the Mathematics Department of the Dresden Carl Friedrich Wilhelm Wander Pedagogic College (advisory, since 1981). Cooperation is aimed at efficient use of existing EDVA [electronic data processing systems] and those being installed for teaching, research, administration and planning in education. In the process, the primary goals are:
--resource sharing, i.e. coordination and cooperation in research and development processes and in use of existing and future hardware
--load sharing, i.e. rational and coordinated loading of all available resources
--data sharing, i.e. supply, exchange and common use of data, information and documentation to meet the backup needs of each partner
--backup sharing, i.e. optimal control of time and schedule dependent processes.

These goals are being implemented on the basis of an organizational agreement by the Council of the Dresden College Computer Centers' Cooperative Association under direction of the Dresden Technical University Computer Center as the decision-making agency organizing and controlling the activity of the six permanent working groups. Here are the features specific to the installation of some members of the cooperative association.

Dresden Friedrich List Transportation College, Department of Mathematics, Computer Engineering and Natural Sciences

This department has a scientific computer center equipped with YeS 1040, an HRS 7200 hybrid computer system, a DIGIGRAF 1008 plotter and various other devices. The existing network of terminals is now being expanded in phases. The scientific department takes care of many tasks in research and teaching; the major ones are:

--Information processing facilities are to be used to make a substantial contribution to efficient organizing of transportation and communication processes, particularly to reducing specific transportation costs. Individual projects which originated under the theme "Industrial Technology Planning Software System," such as administrative regulations, freight train formation planning and others are to be combined into a software system with a common data base organized as a data bank.

--In the computer center, preparation is underway to connect the YeS 1040 to the DELTA computer network with implementation in 1984.

--The computer center is participating in the development and introduction of designs for management information systems for GDR colleges.

--In basic education, all students in the Transportation College are receiving instruction in information processing according to the mandatory GDR curriculum.

--In a specialization course, selected students in basic traffic engineering and electrical engineering courses are tasked with developing, installing and using specialized information systems for transportation and communications.

For these and many other tasks, the YeS 1040 is run continuously over three shifts 22 hours per calendar day with a multiprogramming factor of 2.25. With this high load, common balancing of computer time in the Dresden College Computer Centers' Cooperative Association is of prime importance.

Dresden Engineering College, Information Processing Department Computer Center

The Dresden Engineering College computer center as part of the information processing department has a relatively broad spectrum of hardware, such as the YeS 1022, PRS 4000, Robotron 4200, SKR [Small System] and office computers. The main tasks for which the computer center is responsible as one oriented to education include:

--providing the hardware, technology and software prerequisites for modern education of the students and direct participation in the teaching process

--research and development in small and micro computers to further develop the scientific discipline of information processing

--taking care of tasks as the lead installation in the college for centralized procurement of system documents and within the framework of user associations.

The majority of the over 40 yearly different practical courses is now executed in the interactive mode. As a form of cooperation in the Dresden College Computer Centers' Cooperative Association proven over many years, the resources are also used for the educational tasks of the Dresden TU [Technical University] Information Processing Department. Results of previous research and development efforts which deserve special mention are simulators for various computers, microcomputer operating systems, a BASIC dialog system, a job dialog

system for Unified System computers, PASCAL compiler for office computers, KRS [communication computer system] emulator for the K 1600 system, and the PVS 82 five-processor system, in which the operations are relocated increasingly in the interface area by hardware and software. Current and future directions determining the profile are:

--development and experimental trial of a local computer network

--development of a portable speech processing system

--efforts in computer architecture. A short-term goal is networking the Unified System, SKR [Small System] and office computers installed in the computer center. Providing access to the DELTA computer network through the local network is also planned.

Zittau Engineering College, EDV/RT [Electronic Data Processing/Computer Engineering] Department

The Zittau Engineering College educates students for the GDR energy industry, especially for the sphere of the Ministry of Coal and Energy. This purpose determines the tasks of the scientific department of electronic data processing (EDV)/computer engineering (RT) at the Zittau IH [Engineering College]. The physical base is a YeS 1022 with high-capacity peripherals and a Robotron 4201, which can operate optionally with the AP-64 peripherals of the Unified System computers or as process data processors together with a network model. The department also has the K1520 microcomputer.

--In teaching, the main task is basic theoretical and practical education of the engineer and engineer-economist in the field of information processing relating to practice. Also, the necessary prerequisites for more extensive EDP education have to be provided.

--Department research is aimed at independent contributions to applying information processing in the energy industry, e.g. software for production management of energy systems.

--The department's computer center has to provide the college teaching and research groups with the easiest possible access to the required computer resources. This requires activities in remote data processing as well as making special equipment. In performing computer engineering support tasks, there is close cooperation with the VEB Robur-Werke computer center. Since 1981/82, research group requirements for special resources have increased. Utilization redistribution has also occurred which requires load balancing at the territorial location. To cope with these trends from economic viewpoints, developing further prerequisites, based on division of labor, to connect its own and other computer centers in the sphere of the MHF [Ministry for College and Technical Schools] to the DELTA computer network is a focal point of the cooperation in the Dresden College Computer Centers' Cooperative Association for the Zittau Engineering College. Not the least in this effort are also the experiments with a Unified System computer connected through the manually switched data network to DELTA for optimal design of the technology.

Institute for Medical Information Processing at the Dresden Carl Gustav Carus Medical Academy

The Institute for Medical Information Processing (IFMI) was formed in 1982 from the former Dresden Medical Academy ORZ [organizational computer center]. It now consists of two scientific sections responsible primarily for research and teaching, a department of computer operations and an engineering department. The IFMI is the scientific center for the research project "EDP in the Hospital" and maintains extensive cooperative relations with domestic and foreign partner institutions. The main teaching tasks include further education of physicians, natural scientists and engineers in the dynamically developing field of "Information Processing in Medicine."

Major results of the seventies were the development, testing and practical introduction of EDP projects still in use in the areas of
--patient information and documentation in the hospital and
--automation in the clinic and chemical laboratory.

Current tasks at the IFMI include:
--interdisciplinary development of components of the hospital information system based on new technological solutions
--workstation-oriented application of microcomputers in the hospital to support diagnosis and therapy
--development of the disciplinary basis for applying data banks within the framework of medical information systems
--providing scientific and technical expertise and computer resources for the Dresden Medical Academy and other medical facilities in the territory to support medical care and research. In the international cooperation, the IFMI coordinates in the CEMA the theme "Development of an Automated Information System in the Large Hospital with an Outpatient Clinic Based on the SKR [Small System] and Unified System Computers." Within the framework of the Dresden College Computer Centers' Cooperative Association, IFMI associates direct two working groups. Cooperation spans from common computer time planning with capacity balancing through standardization of operating procedures to making agreements for downtime assistance.

Dresden Technical University, Computer Center

The Dresden Technical University computer center has three main tasks:
--provide computer facilities in modern usage forms for basic and advanced university education, research, administration and planning
--further development of computer applications by its own research projects
--substantial contribution to education in information processing in engineering through its own lectures, exercises and practical courses.

The university has high capacity hardware, which has been installed in the computer center to develop and improve the scientific capability of all 26 departments and to provide computer facilities to the university directorate. It has achieved, beginning with a single computer at the beginning of the seventies, through the several computer systems today, the integration of its main components as the first college installation in the DELTA computer network

for research and teaching and includes
--a large Soviet BESM-6 computer with a satellite YeS 1020,
--a YeS 1022 with an AP 64 display, connected to a GD 71 graphics display for CAD/CAM tasks in the off- or on-line mode
--small computer systems with graduated performance such as the Robotron 4201, PR 4000, DDP 516, SM-4, K 1620, PDP-11
--microcomputer systems.

The BESM6 and Unified System computers are operated by three shifts for 21-22 hours per day.

Computer center research is concerned with
--development and the expansion of the DELTA computer network together with the Academy of Sciences Center for Computer Engineering
--providing interactive work stations especially for CAD
--development and introduction of data processing projects for university use.

A major result in 1983 was the end of the development of the K 8917 raster video display together with the VEB Robotron ZFT [Central Office for Research and Technology], which is intended for CAD/CAM tasks. Computer center instructors guided by the director, Prof. H. Stahl, doctor of engineering sciences, annually educate about 1,200 students in 62 seminar groups from 7 university departments in applying information processing facilities and methods.

In research, teaching and production, the computer center has especially close ties to partner institutions in the the Soviet Union (Dubna, Novosibirsk), the Hungarian VR [People's Republic] (Budapest), the CSSR (Prague), and the Republic of Cuba (Holguin).

PHOTO CAPTION

1. p 6 CAD/CAM work station at the Dresden TU [Technical University]: GD 71 and Robotron 4201 linked to the YeS 1022

Hardware, Uses Described

East Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Vol 21 No 5, May 84 pp 7-10

[Article by Prof. Henry Stahl and Dr. Manfred Frank, Dresden Technical University: "DELTA Computer Network; Development at the Dresden Technical University; Applications in Research, Teaching and Administration"]

[Text] In recent years, a development process was begun which is leading to phased integration of the computer resources in the network. The colleges are taking an active part in this process. The goal is to implement shared access to computer resources concentrated in certain locations, to ensure high loading of them, and to closely link and share, based on division of labor, performance potential in research and teaching. The networking process is proceeding in

stages, the formation of which is essentially influenced by the activity of the institutions. This and the following articles cover the status and phased course in expanding DELTA further and introducing applications for the Dresden college computer network section.

Introduction

This series of articles on the computer network for research and teaching (DELTA), which was established by the institutions in the Dresden region college system, is a direct follow-up to the topical issue published last year on the same subject, in which the Academy of Sciences Center for Computer Engineering reported on its efforts. In the DELTA topology shown there, the communications nodes are linked to two host computers for Dresden. The DELTA concept stated and the components described such as KOMET and the services on the host computers are being used with success in the network and are to a considerable extent the result of implementations of research by the Academy of Sciences and the college system [1, 2].

Since the mid-seventies, the Dresden Technical University computer center has been engaged in computer network research which has contributed to this network topology which is both used in productive operations and being studied to develop it further. A particular focus is network integration of the Unified System host computers.

Based on the topology of the first applications version of the DELTA network, the focus is now on expansion and further development of applications. This is covered mainly in the articles immediately following by the other colleges.

In this article, the subject is the definition and integration of the initial and subsequent efforts on the college section of the DELTA network. With that, it must be considered that the expansion of a network section to a thorough utility structure and the development and application of network technology is a process which spans a number of years.

At this time, the hardware base and system software are being improved. For resources already connected, this means continual adaptation to these dynamics and for resources to be connected, definition of interfaces for integration.

This subject is of general interest to any economic sector engaged in networking of its computer resources. It is faced with the task of defining the first applications versions, subsequent expansions and services to be offered. In doing so, existing basic structures have to be considered and pilot efforts incorporated. This situation will also exist when the public data network with integrated services is introduced in phases.

The DELTA computer network, established first of all as a pioneer effort for research and teaching specifically for this sector, furthers development of commercial solutions by the Deutsche Post and the computer manufacturing industry for the industrial sectors. Tangent lines lie in all three planes in the communications basis, the higher services and in the field of applications.

Hardware Basis of Communications-Oriented Services

Every computer network operation requires a hardware base for communications-oriented services. For DELTA, this base was described in the earlier issue for the first applications version [1]. Certain features should be mentioned here again:
--Levels 1 to 4 in the DELTA architecture match functionally to a large extent the levels in the OSI reference model.
--Levels 1 to 3 were implemented in the KOMET subsystem based on the Robotron 4201 small computer. This computer allows a maximum of four connections (data communication channels to other nodes and a channel to the host computer).
--The highest communication-oriented level 4 (transport level) was implemented on the host computer for the BESM6 and Unified System OS.
--Network services are accessible through the host computer terminals, locally or remotely by using existing DFV [data teleprocessing] systems.

Figure 1 shows an overview of the features in the first applications version (A) and other versions (B, C) up to the first integrated services of an expected public data network. Figure 2 shows the DELTA topology with emphasis on the Dresden section.

This topology already has elements of an expanded applications version (B) which is indicated by the implementation of the remote connection of the host computer by a microcomputer link. The first type of this link operates on the basis of the MPS 4944 microcomputer (developed by the ZfR/AdW [Academy of Sciences Center for Computer Engineering]) and the second type, on the basis of the K 1520 microcomputer (developed by the RZ/TUD [Dresden Technical University Computer Center] and IHZ [Zittau Engineering College]). With this link, configurable for various communication rates, KOMET can be expanded further to a certain extent. For a host computer linked in this way, a time-shared connection can be implemented.

Another aim of applications version (B) is the integration of SKR [Small System] computers as hosts. The Dresden Technical University Computer Center is working on this project. With the capabilities of version (B), the main resources of the Dresden colleges will be linked together in the coming years.

The majority of colleges in the country should be included by the public data network with integrated services (D) and by the preceding interim version (C). Development of the major components for this interim version (C) is already underway [3]. Its major features are shown in figure 1 C. It remains to be seen to what extent these capabilities will be implemented in which sections.

In any case, the transition to microcomputer systems as the basis for the communication-oriented levels means the implementation and application of higher services according to a fully developed OSI architecture can proceed more quickly and with a greater degree of distribution with inclusion of the college computer centers.

The procedure outlined in figure 1 A-D is being accompanied by a process which is now getting underway in parallel with it and which will have a far-reaching

Fig. 1. Evolution of the hardware base for the communication-oriented services used in the college system:

A First applications version of DELTA

levels 1-3	KOMET subsystem, Robotron 4201
level 4	host computer BESM6, Unified System/OS
terminals	at the host computer, use of EFV [data teleprocessing] systems

B Expanded applications version of DELTA

levels 1-3	KOMET with microcomputer links: MPS 4944, K 1520
level 4	SKR [Small System] host computer

C Interim version before the public data network with integrated services

levels 1-4	on microcomputer systems, e.g. the BMP-8: configurability, service standardization, higher number of connections

terminal station: at the network (X.25)

D Public data network with integrated services

levels 1-4	connection-oriented and connection-free services (X.25) transport protocol classes
access	application networks (terminals and hosts)

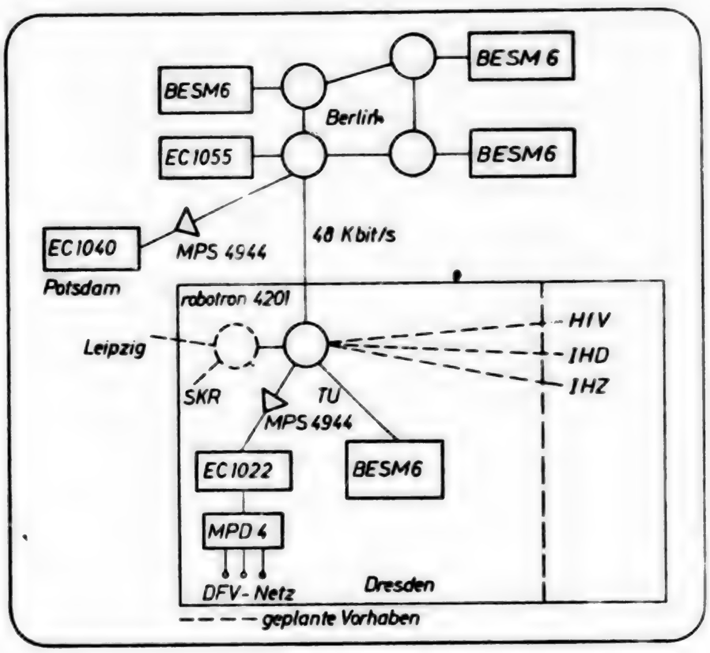

Fig. 2. DELTA topology with emphasis on the Dresden region

Key:

EC = Unified System	HfV = Dresden Transportation College
SKR = System of Small Computers	IHD = Dresden Engineering College
TU = Dresden Technical University	IHZ = Zittau Engineering College
DFV-Netz = data teleprocessing network	--- = planned projects

effect, namely the development of local networks. As reported at the beginning of this issue, local networks are being developed by various methods with architecture similar to OSI, but also according to other level principles. In the colleges, promising efforts are underway (see the following article concerning the IHD [Dresden Engineering College]. Host computers are being included in both global and local networks. This is producing an experimental basis for investigating connections of different types of networks which should still become operative in DELTA.

Higher Services and Applications

DELTA expansion is being accompanied by purposeful expansion of the access capabilities, in particular by local networks, and computer network applications are being developed on the basis of the topology shown in fig. 2. The layer architecture implemented in DELTA ensures that in the following phases even when improved solutions are introduced for the communication-oriented levels, the applications-oriented services can stay as is or be converted at low cost.

When the applications requirements for computer network services in the college computer centers are analyzed (the following articles contain appropriate examples), several task classes of network applications can be identified. An overview of them is shown in the center of fig. 3.

The first task class concerns switching complete jobs between like host computers. The need for this application stems from different loads on the computers or from downtime situations. The processes will be controlled by the system operator. The performance specifics in view of the user remain unchanged. His advantages consist in the raising of the capacity offered and in greater reliability during realization. The basic services in the first applications version (FKD [file copy service], JFV [remote job processing], OC [operator communication]) are ample means for the corresponding technologies.

The topology in fig. 2 shows the possible job streams. Fig. 4 shows the productive application links at that time (Nr. 1-3).

The degree of utilization of these links 1 to 3 is substantially determined by the fact that the listed computers are already well used to capacity by their local jobs, i.e. there is a relative balance of the load. The intensity of productive links increases sharply at once when less loaded or newly installed Unified System resources are connected or an older (BESM6-) computer is replaced; then the corresponding technologies are available.

Moreover, mutual computer use among the Dresden colleges is now quite high; this is also partly the result of the territorial location of the buildings in the city. Additional connections will essentially support these processes.

By using the basic services FKD, JFV and OC [file copy service, remote job processing and operator communication], another task class of applications is now being prepared and developed. Here, job sharing among the network computers utilizing their performance specifics is emphasized (figs. 3 and 4). Applications link L is used especially for teaching by switching jobs for program

Fig. 3. Development of applications on the basis of processing-oriented network services:

A, B, C, D = Applications versions according to figure 1

	Processing-oriented network services	Task classes	Examples of applications
A	basic services of first applications version (without form of OSI architecture 5-7	switching of complete jobs and files of autonomous systems control: system operator	load balancing assistance during downtime file transport
B	--file copying FKP --remote job processing JFV --mailbox MB --operator communication OC	job sharing among network integrated computers by using their performance specifics control: system operator user	job sharing among systems SPEZ I/O batch GRAF I/O scientific DIALOG I/O computing, DIALOG DB data processing
C D	advanced services (with form of OSI architecture 5-7 --virtual terminal --virtual file ----------------- text exchange service	user-controlled applications in distributed systems	information systems applications specific to area concerning real-time processes

Key:

SPEZ I/O	special input/output
GRAF I/O	graphics input/output
DIALOG I/O	program generation in interactive mode
DIALOG DB	data bank operation in interactive mode

Fig. 4 Special applications of computer network services in the topology shown in fig. 1.

	Application	Computer I	Function I	Host II	Function II
I	load balancing	YeS 1022 TUD	I/O-OS jobs	YeS 1055 AdW	processing
J	downtime assistance (TUD BESM6 down)	YeS 1022 TUD	I/O-BAMOS jobs	BESM6 AdW	processing
K	use of special resources	BESM6 TUD	I/O-BAMOS jobs	BESM6 AdW	processing
L	better access	ESER (office computer)	Dialog I/O	BESM6 ESER	processing
M	distributed application	SKR	Graf. I/O	BESM6 ESER	background processing/ storage
N	distributed application	SKR	data bank use in interactive mode	ESER	background processing/ storage

Key:

TUD = Dresden Technical University
AdW = Academy of Sciences
ESER = Unified System Computer
SKR = Small System Computer

generation and for input/output in certain basic laboratories. Link M supports targeted engineering activities; it makes graphics components of the SKR [Small System] available to BESM6 and Unified System. Link N is intended for applications in the administrative area.

When the basic services of FKD and JFV [file copy and remote job processing] are used, network usage is essentially controlled by the operators using it who coordinate usage by OC [operator communication].

The greater acceptance of user control requires advanced services as they are characterized by "virtual terminal" and "virtual file." These services are being developed for applications versions (C, D) [3]. They are the means for developing applications in distributed systems.

Concluding Remarks

The process character of integrating computer resources in networks and providing efficient service applications has become evident in this article. The college institutions and their industrial cooperation partners will be facing this task. Of the overall association concerns, the stages presented are indispensable steps in the transition to the public data network with integrated services and applications specific to areas. Carrying out this pioneer effort is the goal of the Dresden region colleges.

PHOTO CAPTIONS

1. p 7. BESM6 host computer console in the Dresden Technical University computer center

2. p 7 Row of BESM6 Magnetic tape drives (Photos (4): Schlechte)

3. p 8. Henry Stahl studied at the then Dresden Technical College and at the Leipzig Karl-Marx-University from 1949 to 1953. From 1953 to 1968, he was employed in industry, in the Pirna Power Station Equipment Manufacturing VEB, in research and development in the field of strength and vibration in a responsible position. During this time, he obtained his doctorate in engineering. In 1968, he was appointed to the professorial chair for "Electronic Data Processing in Mechanical Engineering." Since 1969, he has also been the director of the Dresden Technical University computer center. He is a member of national and international groups in the computer engineering and data processing discipline.

4. p 8. Manfred Frank studied mathematics from 1952 to 1956 and physics from 1958 to 1961 at the Leipzig Karl-Marx-University. In 1968, he obtained his doctorate in science at Dresden Technical University by his efforts in the field of solid-state and radiation physics which have been widely accepted. After a temporary change in specialization, he was appointed a docent for mathematical cybernetics and computer engineering in 1970 and directed the section for the large Soviet BESM6 computer at the university. Since 1976, he has been deputy director for research in the computer center and is engaged in particular with the development of the computer network in the college system.

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Network Integration, Uses

East Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Vol 21 No 5, May 84 pp 10-14

[Article by Prof Dr Horst Fischer and Dietmar Reichel, Zittau Engineering College; Prof Dr Reinhold Richter and Dr Klaus-Dieter Rieck, Dresden Friedrich List Transportation College; and Dr Bernd Naether and Guenter Schreiter, Dresden Engineering College: "Plans for Connections and Applications by the Dresden District Engineering Colleges for the DELTA Computer Network"]

[Text] In 1984, the computer centers in the Transportation College, the Dresden Engineering College and the Zittau Engineering College were linked to the DELTA computer network being developed by the Academy of Sciences and the colleges. Thus, our colleges, compared to other GDR colleges of equal importance, are achieving a status worthy of note. Processing of certain tasks for research and teaching can be better coordinated and new types of tasks can be tackled.

Dresden Friedrich List Transportation College

The GDR transportation sector is now faced with the comprehensive task of reducing specific transportation costs and saving energy, materials, time and manpower. The Transportation College (HfV) is participating in this task with a considerable scientific potential. It is specifically tasked with further improvement in planning, directing and organizing the transportation process. In most cases, deterministic models and projects using very large amounts of data, organized as data banks, and simulation models have to be prepared for this. Naturally, solutions must be found which improve previous processes or even make them optimal. This cannot be done without the facilities and methods of informatics.

Transportation of people and freight is handled by traffic networks expressly developed for this. This alone means traffic planners are used to thinking in terms of networks and that developing, organizing and operating networks is a standard part of their job. But this is not the only reason development and use of computer networks in transportation has become a relevant task. There are rather a number of objective problems which could not be, or only very inadequately, handled without the existence of a suitable data, terminal and computer network. Similar statements can also be made for the large field of communications which is also a Transportation College task.

The continually increasing use of resources available to the Transportation College for this purpose has affected student education for both transportation and communications. Although no information processing specialists are educated at our college, all our students taking the basic courses in electrical, mechanical, civil and traffic engineering and economic sciences must take relatively broadly aimed basic courses in this field. These courses enable students to set up algorithms to solve simple problems in their specialty, formulate functional programs using a problem-oriented programming language

and write them as jobs for the YeS 1040. About 10 percent of each year is spent on information processing in their specialty or in a special course expressly for this.

More detailed education in specialized courses, on a content level equivalent to the cadre group IVa, with stress on applications aspects is aimed at ensuring that the future graduates know the capabilities and some basic modern methods of applying computer facilities and can make use of applications in their professional groups and for their specialty problems. Work with computer networks is also part of this.

For several years, the key hardware in the Transportation College computer center has been the YeS 1040 with 1M bytes of main storage. There are six YeS 5061 disk units with moving heads and eight YeS 5010 magnetic tape drives for external storage. The operating system is the OS/YeS MVT 6.1. After the end of the terminal trial operation based on the A 5110 and A 5120 office computers, the terminal network is now being expanded by connecting K 8912 video display terminals. This indicates the current capabilities and limits offered by the college computer center hardware. Increasing requirements in research and teaching demand expansion of available resources and the imminent connection to the DELTA computer network represents a good capability for this.

The link is aimed primarily at making the advantages of advanced information processing facilities accessible for special tasks at the Transportation College. We also see ourselves as those imparting the knowledge which will be obtained in development and operation of the computer network and which the German State Railroad, for example, can use in developing its own computer network. The link also offers better prerequisites for contributions to research in computer networks such as, for example, the introduction of the EDAS data management system developed at the Transportation College for Unified System data file archiving and protection in network operation. EDAS, in conjunction with the network software file copy service, would allow, for example, setting up user groups (magnetic disks) at host computers in which all data files needed at the host, but which are resident on remote computers in the network, are managed. The data files can be archived at the host computer when they are not being used for a long time, and they could be activated, updated, protected and redesigned by the data file owner without requiring him to be more closely acquainted with the host computer operation technology.

The following special applications capabilities of network operation are now anticipated:
--Considerable technological improvement of cooperation with other Dresden region college computer centers is expected. Thus, e.g. document input and output can take place at these centers when users of our installation get out of its resources area.
--Naturally, information exchange between the computer centers connected is also improved by the computer network mailbox service.
--Pilot application cases for transportation and communication are to be developed for the computer network from the college task complex explained above.

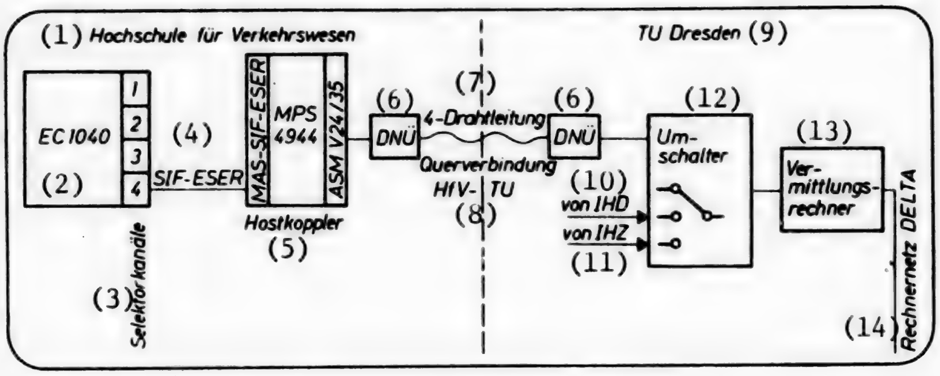


Fig. 1. Technical concept of computer network connection

Key:

1. Transportation College
2. YeS 1040
3. selector channels
4. SIF-ESER [Unified System standard interface]
5. host link
6. DNUe
7. four-wire line
8. Transportation College - TU [Technical University] interconnection
9. Dresden TU [Technical University]
10. from IHD [Dresden Engineering College]
11. from IHZ [Zittau Engineering College]
12. switch
13. switching computer
14. Delta computer network

--Transportation College users will have access to resources not available at the Transportation College. Examples are YeS-2 hardware and software, larger configurations, special peripherals such as microfilm output and others. For example, the administrative regulations for the entire GDR freight traffic are regularly being output on microfiche.
--The connection to the computer network offers a real basis for a functional link so that special software components are implemented and maintained only in individual computer centers. The SIMULA compiler in the Berlin Center for Computer Engineering should be used by our college as the first test example in this respect.
--Load balancing and assistance during downtime are possible for the cooperating computer centers on a small scale.

Since the hardware prerequisites for an in-house switching computer are not available now at the Transportation College, only the link through a Robotron 4201 at the Dresden TU [Technical University] with alternating interconnection of various installations is now implementable (fig. 1).

The described concept of an alternating interconnection of the YeS 1040 with other installations to a packet switching computer at the Dresden TU [Technical University] operating in the Delta computer network offers these advantages: Hardware cost is relatively low and the communication software does not have to be operated by the Transportation College computer center.

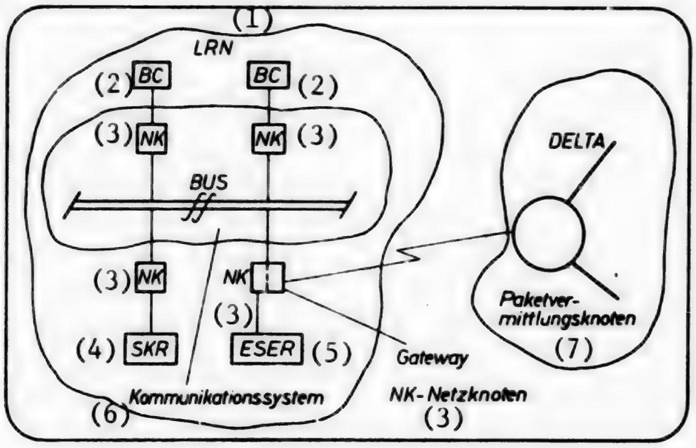


Fig. 2. Model of the LAN and its link to the Delta computer network

Key:

1. LRN [local area network]
2. BC [office computer]
3. NK [network node]
4. SKR [Small System computer]
5. ESER [Unified System computer]
6. communication system
7. packet switching nodes

For increased demands on network operation, which will be made both by and on the Transportation College computer center, to what extent a more permanent link has to be set up should be investigated in a later phase. The engineering efforts for linking the Transportation College YeS 1040 to the Delta network are being performed by the Transportation College computer center engineering department. However, we consider ourselves fortunate to be able to draw on the support of colleagues at the computer centers at the Dresden TU [Technical University], the Dresden IH [Engineering College] and the Zittau IH [Engineering College]. Thus, we can say that the Delta computer network organization and future operation is another outstanding example of effective cooperation between the college installations in the cooperative association.

Dresden Engineering College

The start on the concept and initial implementation plans for the computer network problem at the Dresden Engineering College was made in 1982; in the process, the primary orientation has been on the development of an LRN [local area network = LAN] which also has the capability of being linked to the Delta computer network for its further expandability.

Although the design and implementation of a LAN including its link to the Delta computer network is most importantly a topic of research, the motives for undertaking these efforts originated from the Dresden Engineering College computer center commitment to make a major contribution to information processing development and application particularly for the education process at the college. The main user of the computer center is the college information

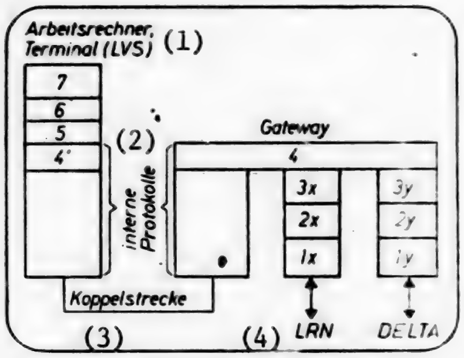


Fig. 3. Terminal system architecture

Key:
1. main computer, terminal (LVS [local processing system]
2. internal protocols
3. switching row
4. LRN [local area network]

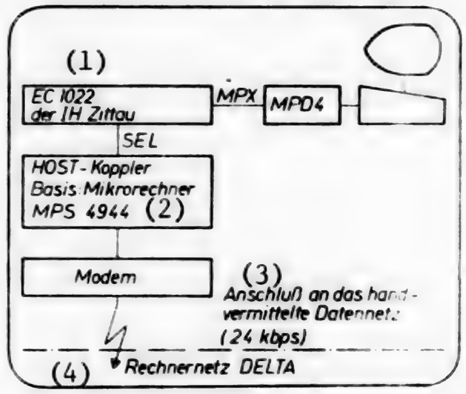


Fig. 4. Link configuration

Key:
1. Zittau Engineering College YeS 1022
2. host link based on MPS 4944 microcomputer
3. link to manually switched data network (24 kbps)
4. DELTA computer network

processing department and it is clear that the capability of the computer hardware base is a determining factor for shaping the basic studies direction of information processing.

In this sense, the efforts are aimed at
--providing user services offered by the resources of the LAN and the Delta computer network to the decentralized user interfaces
--providing unused computer center resources through the Delta computer network for the cooperative partners operating in the network
--future development of new telecommunication forms such as mailbox service and others.

The immediate goals for a first implementation phase for using the network link in the education process are
--access to YeS-2 resources for operating system and other specific practical courses, and
--demonstration courses for local and global computer network applications.

Access to the Delta computer network is planned in two expansion stages:
--connection of a Robotron 4201 batch terminal and main computer
--connection of the LAN through a gateway.

The concept for expanding a LAN, including its link to the Delta computer network, is shown as a model in fig. 2.

Design plans for the LAN communication system call for a bus structure with K-1520 network nodes connected as the network interface for the mentioned heterogeneous computer systems of ESER [Unified System], SKR [System of Small Computers] and office computer hardware.

Following the international trend toward standardization, the communication problems occurring in the LAN and for the Delta computer network should be described and worked on based on the ISO Reference Model (ISO DP7498). This model provides seven levels, each of which is assigned clear functions. Communication within a level, which can be distributed throughout over several computer systems, is controlled by protocols.

All functions needed for the actual data communication are assigned to levels 1 to 4. Because the operating systems now available are hardly designed for setting up computer networks and for other reasons as well, these communication-oriented levels are stored in the network nodes also in accordance with ECMA TR/13. This type of procedure opens the possibility of installing a special network node of the LAN as the gateway, as a transformation member between the LAN and DELTA (fig. 3).

For communication between the main computer (DELTA terminology) and the LVS local processing system (LAN terminology) on the one hand and the gateway, the internal protocols of available access methods of remote data communication should be used, as long as they are suitable for decentralized control or can be easily adapted.

The partly extremely different protocols for data communication between global and local networks are taken into consideration in levels 1 (physical), 2 (link) and 3 (network). In level 4 (transport), only a single protocol (standard ECMA-72) is provided for both network types.

At present, the concepts for implementation of the LAN, particularly for the lower levels, are already quite clear and the first hardware and software efforts are now in the test phase. A not inconsiderable task for the following time consists in solving problems arising for the link between the LAN and DELTA computer network such as protocols and protocol classes, development efforts for the gateway and others also by coordinated cooperation with the installations in the Dresden College Computer Centers Cooperative Association and with the Academy of Sciences Computer Engineering Center.

Zittau Engineering College

Zittau Engineering College educates engineers and economists for the GDR energy sector. The education profile results from the requirements of building, operating and ensuring a high availability of installations and processes for generating and distributing energy and ensuring efficient energy use. The energy system is complex and intricate and can be considered a hierarchically managed system from the overall view of its administration. The functions of this system have to be implemented more efficiently than up to now when capacity has been specifically increased. Of necessity, this requires the development of generally automated control systems. From the

technical view, this leads to the phased establishment of computer networks in the energy sector, which include all types of hardware, beginning with local microcomputers in transformer or power stations through the monitoring computers and others in the form of small computers to the large mainframes in the state main energy centers.

This engineering development is supported in teaching and research at the Zittau Engineering College by active contributions. Thus, students and college instructors have been and are developing and testing in practice hardware and pertinent software developments in a preliminary stage of special applications of computer networks. Results of these efforts have been integrated, e.g. in the microcomputer-controlled switching facilities of GDR electrical equipment manufacturing and are offered on the international market.

The requirements on the college in the process of teaching and research resulting from the internationally observed development of science and technology compel a forced application of information processing means and methods to produce economically efficient scientific results and highly qualified graduates for the energy sector.

This is producing two development trends to computer hardware use to support the main processes at the college:
--The various resource requirements of teaching are compelling the development of conditions for linking the Zittau Engineering College computer center to the DELTA computer network.
--Intensification of the main processes is requiring expeditious, thus direct, access to the college computer resources for teaching in the vicinity of the workstations.

On the First Development Trend:

Student and research performance can be stimulated when each student or staff member can easily use the necessary aids without delay. This requires, among others, direct access to various information processing facilities to meet the demand. It should be remembered that there are complicated and often a large amount of operations and data in comprehensive information processing of network analysis or environmental protection in the nuclear energy area. This requires special resources with respect to software, data and hardware (e.g. graphics peripherals), which are not available on a large scale at the Zittau Engineering College, but are installed at industrial branch institutes or other colleges for reasons of efficiency. The decentral location of the Zittau Engineering College requires for economic reasons efficient access to these resources by using the manually switched data network as well (see article by Stahl/Frank). Those were the motives, in addition to efficient resource utilization of the Unified System hardware installed in the Zittau Engineering College computer center by load balancing, for our application for the link to the DELTA computer network.

Staff members from the computer center among others are working on preparing the link of the college computer hardware to the host link in a division of labor. Thus, the capability of making equipment has been developed in the computer center.

Fig. 4 shows the connection of the Zittau Engineering College YeS 1022 to the computer network.

The Zittau Engineering College is also participating in experiments to find the optimal technology of remotely linking a Unified System computer through the "slow" data lines of the manually switched data network during connection to the packet switching network.

The goal is to form the computer network link for selected utilization cases for operational production in 1984.

Long-term plans call for contributions to the data network for efficient solving of energy problems in teaching and research based on central data banks on special technical and technological objects, structures, properties and methods of behavior of energy systems. The first concepts are now being developed for this.

On the Second Development Trend:

The prevailing centralized batch operation at the Zittau Engineering College has reached the limits of capacity, not as far as the resources are concerned, but with respect to adding other active users. It is inconvenient and often not very efficient. Computer support to teaching and research has to be immediate and thus meet the everyday demand, especially in teaching. More intensive experience in using the computer as a tool must be made available to the student. He must be free to work with the resources directly needed himself through a display in order to also train for later industrial use. A way to achieve this goal is to set up a local computer network at the Zittau Engineering College with a suitable gateway to the GDR network.

To begin with, we plan to install alphanumeric terminals connected through data communication equipment to the central Unified System computer in the college; this has been implemented in part already, at least in each building where scientists and students work. This is a first expansion stage of a passive terminal network with a tree structure. This tree structure resulted from a simple unconventional solution with available and self-made hardware by using the telephone network. Connection of more alphanumeric displays is planned in 1984. The hardware is based on the K 8912 and K 8914 video displays among others.

Parallel to that, efforts are underway to implement an automatic system for measured value acquisition and processing in a large experimental field. The connection of this system to the local network is planned for the future.

Also worth mentioning is the current study of the use of computer-aided workstations for process and design engineers to intensify teaching and research. Both processes depend on development of detailed concepts for a structure and operating method of a LAN in our college. In the process, the Zittau Engineering College has the support of specialists at the Dresden Technical University and Dresden Engineering College.

Both development trends described are being mastered by the Zittau Engineering College in cooperation and sharing of labor with the Dresden College Computer Centers Cooperative Association. This united power allows a smaller number of specialists in computer engineering in the college computer centers to take part in modern developments in the interest of their particular college without involving all of the specialists.

PHOTO CAPTIONS

1. p 11. Horst Fischer has a doctorate in engineering received at Ilmenau TH [Technical College] in 1966. He was first engaged in the field of technology. In 1967, he began working in EDP (project development, IV [information processing] applications in technology). In 1970, he was appointed a professor of data processing at Zittau Engineering College. In 1979, he was awarded a second doctorate at Dresden TU [Technical University].

2. p 11. Bernd Naether studied from 1969 to 1973 at Dresden Engineering College, Department of Information Processing, and became the computer operations section leader in the college computer center in 1974. Since 1981, he has been the director of the computer center. In 1982, he received his doctorate in the field of computer center technology.

3. p 11. Dietmar Reichel holds an engineering degree. He has worked in EDP since 1971 (non-numeric information processing, computer networking) at Zittau Engineering College.

4. p 11. Reinhold Richter studied mathematics at Dresden TH [Technical College] and Leipzig University. In 1952, he became a member of the staff for the professorial chair of mathematics at the Dresden Friedrich List Transportation College. He received his doctorate in 1959 and became a lecturer in 1965. His specialty is information processing applications in traffic systems. He was appointed a professor in 1966. He heads the scientific department of computer engineering and the computer center at the Transportation College.

5. p 11. Klaus-Dieter Rieck studied mathematics at Humboldt University and has been engaged since 1957 in research and development in aero- and thermodynamics. In 1973, he was awarded his doctorate in engineering for an information processing application in engineering mechanics. He is now responsible for basic software maintenance and development in the Transportation College computer center.

6. p 11. Guenter Schreiter has been working at the Dresden Engineering College since 1969. In 1975, he completed his studies in the information processing department. For some 10 years, he has worked in development of system documentation in the field of remote data processing and since 1981 with data communication in computer networks.

Software for ESER Computers

East Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Vol 21 No 5, May 84 pp 14-17

[Article by Dr Norbert Wulst, Frieder Wolf, Herbert Vetter, Dieter Schoessinger, Dresden Technical University]

[Text] Software for running Unified System computers on the DELTA computer network has been implemented in the OS/YeS operating system. This system is also being developed for SVS.

The network software is divided into a transport service which is always available as the "network kernel" task during network operation and takes up 90K bytes, and into applications, the components of which are started when needed by the user (sender) or the network kernel (receiver) as independent tasks. Applications available are the file copy service, remote job processing, mailbox service and interactive communication (operator communication).

Main applications are the user-controlled file transfer and remote job processing in the sense of load sharing. Operator communication and mailbox service are used for processing support. Based on the Delta publications in [1], this article presents the Unified System implementation of the network components and explains the basic method of operation.

Linking Unified System Computers to DELTA

With the expansion of DELTA as a national computer network for research and teaching, supported by leading institutes of the GDR Academy of Sciences and the college system, the first step was taken toward coming to terms with the technology of open communication systems.

The KOMET packet switching network [2] is assumed for the form of computer-to-computer communication to be considered here.

A main computer has to be connected therefore to an accessible KOMET system packet switching computer. Main computers nearby can be connected through the modified AS4 link controller of the Robotron 4201 packet switching computer and for remote links, through a host coupler based on the MPS 4944 microcomputer. Four BESM-6 and two Unified System computers are now operating in this network. The connection is ready for additional Unified System computers.

Overview of Unified System Network Software

The Unified System network software includes all the base software and applications, made available on Unified System computers, for operating in the DELTA computer network. This network software is divided into a transport service (TD) and the applications used in this service. The TD realizes communication

requests and service jobs from applications tasks and the operator. Logical connection terminals are resident on the linked main computers for process communication. A protocol has been defined to facilitate message exchange between these terminals. The terminals are called transport stations. The logical link for message communication is defined by the transport stations assigned at the time. Control of communication between two transport stations through the communication network is therefore an end-to-end control.

For service, the TD [transport service] offers topology information to the main computers currently active on DELTA, information on current system loading and statistics. Components which are always needed to implement a remote communication are kept in a network kernel. In addition to the transport service, it also makes base elements available for the applications and synchronizes operation of all components.

With that, the transport service is made available by the transport station (TS) and the data file I/O process (DIO). Through the external interface of transport service, which has the level of a simple Unified System access method, the application tasks transfer the data to the TS, which fragments it according to the transport protocol, formats it into packets and forwards it through the DIO to a local or remote packet switching computer. Data reception is the reverse process.

The application services have been implemented in distributed send and receive tasks and operate in the phases for
--connection establishment
--information communication and
--connection release.

A user can call the send portion of an applications process, to which parameters for the receive portion can be passed. In the connection setup phase, the RCVANY component of the destination computer sets up a receive part dynamically which matches the send part. The send part and the resulting receive part then implement the phase of information communication and connection release for the respective application job.

Selected status information of all transport service components is collected by a statistical process (STAT) into a data file and analyzed from there.

Communication and synchronization of all network software local tasks, including the subtasks and operator communication, are based on a local process communication, which is based on the operating mechanism of the MODIFY command.

Overview of Implementation of the Network Kernel Part

All components always needed to implement remote communication are combined into the network kernel. Its availability ensures the data communication service for the applications through the transport service user interface.

It has these parts:
--an organization task (TSKERN) as the main task for starting and

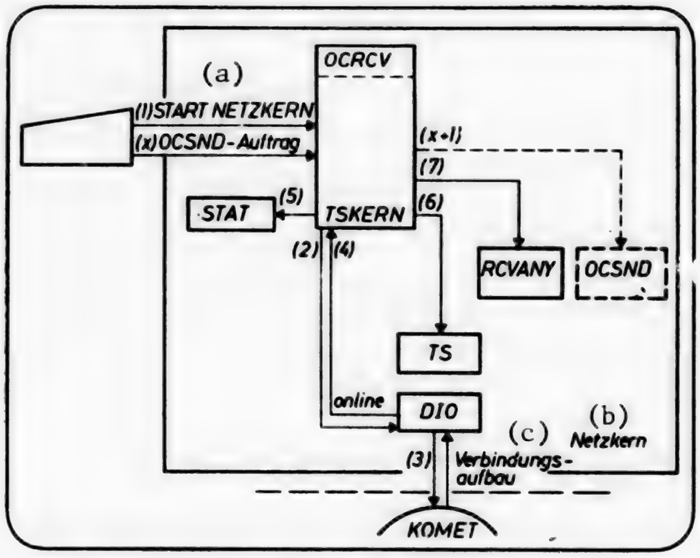


Fig. 1. Overview of network kernel part

Key:
- a. start network kernel
- b. network kernel
- c. set up connection

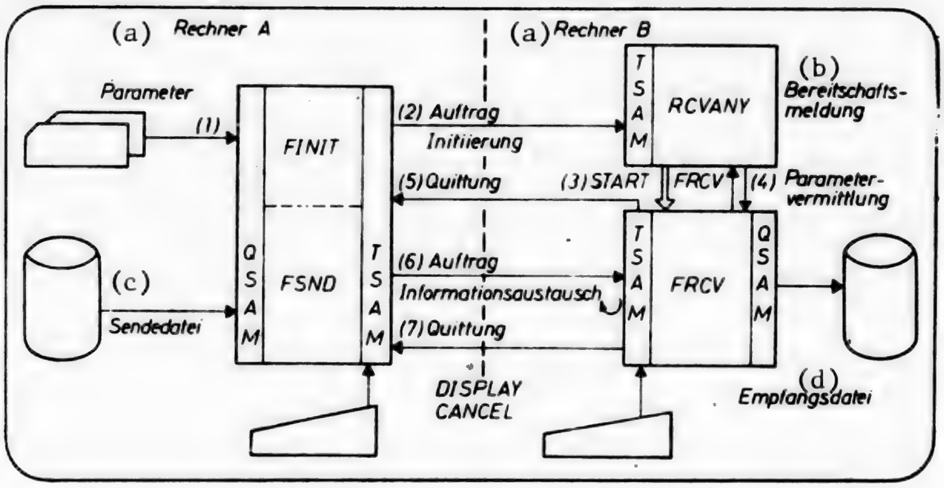


Fig. 2. File transfer in DELTA

Key:
- a. computer A, B
- b. sign-on message
- c. send data file
- d. receive data file
- 2. job initialization
- 4. parameter switching
- 5. receipt
- 6. job information exchange
- 7. receipt

synchronizing the components linked as subtasks.
--the transport station (TS) with the task of end-to-end control and providing the interface for the applications process. The data I/O process (DIO) as the link between the packet switching computer and the transport station.
--the initialization component (RCVANY) for the receive part of the applications.
--the temporarily set up send part (OCSND) of operator communication as the base application. The receive part (OCRCV) is a component of the TSKERN task.
--the statistical component (STAT) for receiving and storage of statistics on all components.

Fig. 1 shows an overview in which the individual actions for activating the components are shown by (1) to (7) to start the network kernel.

Application Components

In addition to the base application for operator communication, these services are available on a Unified System computer:
--file copy service (KFD)
--remote job processing for Unified System (JFVE) and BESM-6 jobs (FVB)
--mailbox service (MBD) [1].

These applications implement the remote communication through the TSAM Unified System network access method. Major TSAM functions are:
--log on / log off of application task (subscriber)
--opening/closing of communication stations (ports)
--send/receive information in lengths up to 6,144 bytes
--notification of current network topology
--reset all jobs of a port
--link to local process communication and thereby capability of operator communication through the MODIFY command.
--link to an extended timeout service.

TSAM is made available as a set of external procedures in PASCAL and as macro calls in Assembler.

The method of operation of applications in the DELTA computer network should be explained in more detail here using the example of the file copy service.

The file copy service (FKD) is a distributed system which transfers sequential files, components of partitioned data sets and random files between DELTA network computers (currently Unified System OS and BESM-6). Content of files transferred is transparent to the service.

In the OSI model sense, the file copy service includes levels 5 to 7. A file is transferred by using the DELTA transport service and transfer is controlled by the FKD protocol. There are tailored functions particular to the service to set up a logical connection.

Fig. 2 shows a simplified diagram of file copy service components in the Unified System implementation. It shows the subdivision of this service into the

distributed send (FSND) and receive process (FRCV). RCVANY supports the logical connection setup.

FSND contains the initialization part (FINIT) which organizes the input and distribution of parameters. In the process, the destination computer identifier and input data file description are forwarded to FSND, while a service characteristic, data file description of output data file and the send communication station address provided for the information communication are transmitted. In RCVANY, the service characteristic determines the selection of the receive procedure to be started and the selection of the corresponding file.

After the receive task is started, RCVANY gives the send communication station address to FRCV, which ends the initialization phase with a start acknowledgment sent to FINIT, which contains the receive communication station address. FSND and FRCV access the external medium through the QSAM access method. Data file parameters for the send and receive data files are given by the user on the send side.

Use of the transport service is implemented through the TSAM network access method. Among other things, TSAM implements here the uniform program entry point for time control and for the operator command DISPLAY (display of logical sets transferred so far) and STOP (initiation of abort protocol). The communication width is a maximum of three lettergrams.

The transfer is ended by a set with a special flag. The send and receive process releases the files in question and ends its operation. The task RCVANY remains active together with the transport service and thereby offers the capability of setting up a new logical link for file transfer at any time.

Remote job processing is a special application of the file copy service for remote processing of main computer jobs in the DELTA computer network. It implements a technologically simply operable remote processing of jobs and the transfer back or redistribution of output information.

For Unified System jobs, it depends on the use of the file copy service with data types for job input or output of information and its link with system procedures for job input (RDR) or output (WTR). The basis for this is the assignment of certain output classes of the YeS/OS operating system to output locations in the DELTA computer network.

Transfer of BESM-6 jobs is based on using the file copy service with the data type random. Input and output data are handled with special reader and writer procedures.

Summary

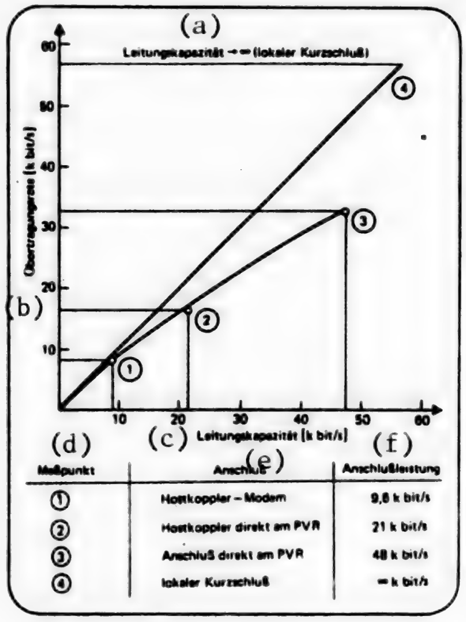
The transport service can theoretically handle up to 63 application processes at the same time. In practice, up to four parallel transfers are feasible as a function of communication line capacity, whereby each incoming line in question is already loaded with credit = 2 during use of the file transfer service in an individual transfer. Fig. 3 shows the channel load in three different

Fig. 3. Communication rates of FKD [file copy service] for credit = 2

Key:

1. host coupler - modem, 9.6k bits/s
2. host coupler direct to PVR [packet switching computer], 21k bits/s
3. link directly to PVR [packet switching computer], 48k bits/s
4. local short circuit

a. line capacity→∞ (local short circuit)
b. communication rate (k bits/s)
c. line capacity (k bits/s)
d. measuring point
e. link
f. link capacity



connections and a comparison to the short-circuit capacity of the transport service. One can conclude from fig. 3 that the effective communication rate is 70 percent with a 48k-bit line and 95 percent with a 9.6k-bit line. Between both of these values is the case of the host coupler connected directly to a packet switching computer with a value of 80 percent. The load curve shown contains the protocol portion in an order of magnitude of 40 percent.

It follows that a YeS 1022, for instance, has adequate processor performance for the demonstrated capability of using the KOMET communication system and that the Unified System network software operates efficiently for the application cases considered with the channel capacity offered.

PHOTO CAPTIONS

1. p 15. Norbert Wulst has worked in the Dresden Technical University computer center since 1972 and obtained his doctorate in engineering in fluid mechanics at this university in 1973. After working with Unified System operating systems and processes, he has been engaged in computer networking problems since 1976. He works in the field of computer network architecture, protocols at the upper levels and computer network applications.

2. p 15. Herbert Vetter obtained his degree in mathematics at the Dresden Technical University in 1971. He then worked in the field of EDP design. Since 1977, he has been engaged as a systems programmer in the computer center at this university and has worked in developing computer network software primarily on problems of operating system interfaces, linking of computers and remote job processing.

3. p 15. Frieder Wolf obtained his degree in solid-state mechanics at the Dresden Technical University in 1973 and has worked there in the computer center since then. He is working on the development of specialized Unified System operating systems. For the Unified System network software, he implemented the transport service and synchronized the development of the entire system.

4. p 15. Dieter Schloessinger has a degree in geophysics and worked in project processing at the Leipzig Geophysics VEB. Engaged in the Dresden Technical University computer center since 1969, he developed software for the URAL-14 EDP system and Unified System computers. For the Unified System network software, he implemented the components of process communication, external interface of the transport service and the file copy service.

5. p 17. YeS 1022 host computer console at the Dresden Technical University

6. p 17. Row of magnetic disk units for the YeS 1022. Photos (6) by Schlechte.

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Software System Recommended

East Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Vol 21 No 5, May 84 pp 18-20

[Article by Hartmut Anke, Joachim Barthold, Dr Peter Elste, Dresden Technical University: "Computer Access in the Heterogeneous System"]

[Text] Practical use of a computer network made up of heterogeneous host computers implies the requirement of making the different resources available to the total network. With solutions to this problem, the user gets efficient access capabilities and the manager can improve the economic effectiveness of expensive installations. In what follows, a software

system is presented which promotes acceptance of the nonhomogeneous DELTA computer network.

Aspects of User Views on the Computer Network

Productive operation of application versions of the DELTA computer network offers the user new capabilities of using computers. By publicizing the results achieved within the framework of DELTA development, a large circle of potential users have become familiar with this problem [1]. At the same time, aspects of the user views on further develop of DELTA assume more importance. Several can be characterized as follows:

--The computer network represents a sum of separately usable shared resources. This means a job must be formulated so that it can be processed by a single node.

--Each host computer offers a characteristic service. Knowledge of the operating method of the destination node computer should correspond to the problem solution for the user.

--A user can access the network through a host computer which fits his operating conditions, experience and capabilities. The selection of the destination node should not be influenced by type of access to the network.

--Response times should be determined by the importance and the type of problem to be solved and the user should be able to plan on them.

We tried to take these user view aspects into consideration during the development of the software described below.

Conditions for Development of a Network Technology

The current application versions of the DELTA computer network link Unified System (YeS 1055, YeS 1022) and BESM-6 computers. The basic services for network operation are used for

--file transfer and

--telecommunication.

Computer capacity at remote hosts in the DELTA computer network can be used through the services of

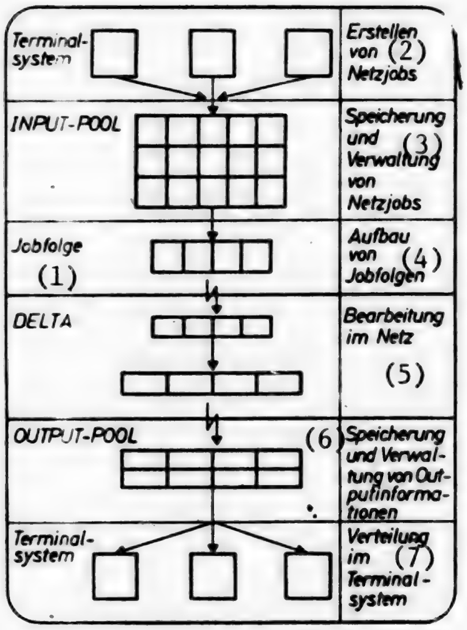
--remote job processing

which were developed on the basis of the file transfer service. These services are available to the operator of a DELTA network node to implement user requirements for the network. An interface is required for this for jobs to be processed remotely because of the incompatibility between the BESM-6 and Unified System computers in operating technology of computer operation. Arranging the main activities of remote job processing and their destination facilities in a process flowchart, we get the diagram shown in fig. 1. Only the batch mode of processing is shown here as a special DELTA property. An explanation of fig. 1 follows:

--Terminal System

The software and hardware capabilities on the host computers for formulating network jobs or for output of results can be very different. The classical

Fig. 1. Process flowchart in DELTA



Key:

1. job stream
2. generation of network jobs
3. storage and management of network jobs
4. set up of job streams
5. processing in network
6. storage and management of output information
7. distribution in terminal system

method of job formulation by assembling a batch of punched cards which is given to the computer center by the user currently still dominates. But we must be prepared for increased use of job formulations without paper data media in future. With expanded use of hardware and systems for interactive operation, generating network jobs in the interactive mode will be important. With the development of local networks, another source for such jobs will arise in future. Alternative solutions to customary output media will also extend the spectrum for output.

--Input Pool

A number of economic (loading of equipment by network software, costs of communication lines, etc.) and technical (line availability, maintenance times) conditions require planned, concentrated network use. This is why it is necessary to gather, store and manage user jobs coming in irregularly in general.

--Job Stream

Job streams for the same destination computer are selected from the input pool are and sent at feasible times. In doing so, checks are necessary to adhere to the syntax requirement for job formulation at the destination computer. Job content modification may also be necessary (e.g. insertion of accounting numbers specific to the destination computer or declaration of special libraries). Other criteria besides the destination computer identifier must be taken into account to set up the job stream. Thus, the predicted processing duration the at destination computer for the stream compilation is important to be able to ensure the term for sending back the results. Optional criteria which play a role in processing of local jobs are naturally to be considered likewise for remote job processing (priority, completion time, resource requirements etc.).

--DELTA

The compiled job streams are sent by means of a version of the remote job processing service depending on the destination computer. They are processed on that computer within the framework of technology for processing local jobs.

--Output Pool

Output information from the job streams is received and then stored and managed in an output pool. This ensures that the network transfer and output in the terminal system can be separate in time and communication paths are used efficiently. Moreover, adaptation to operating conditions in the terminal system is easy (e.g. restricted time availability of devices).

Implementation

To implement user access in heterogeneous systems, a software system for remote job processing of BESM-6 jobs (JFVB) under YeS/OS on Unified System host computers was developed at the Dresden Technical University computer center. The JFVB contains algorithms for
--overcoming the incompatibility of Unified System OS and BAMOS (assignment of logical devices, data structures, codes, etc.)
--procedural support.

By appropriate structuring, adaptation to technological conditions for the JFVB user can easily be implemented. The definition of system internal interfaces allows expansions to connect additional I/O media for BAMOS jobs.

Fig. 2 shows the current JFVB version 12/83. BAMOS jobs can be input by punched cards or magnetic tape. Magnetic tape thereby forms the last stage of a data acquisition procedure for BAMOS jobs through an office computer. The function JFVB-CREA makes a job sequence from the INPUT pool ready to send; it can then be sent to a BESM-6 host by JFVB-SEND. Both processes are event synchronized by a simple mechanism to prevent unintentional overwrites or duplicate sending. The job formulation (BAMOS-JCL) syntax is checked to some extent. The job stream received by the BESM-6 system network process is put on an external storage unit; from there, it is made ready for processing in another processing step under control of the BAMOS operating system after the data structure is changed. After processing, the results are placed on an external storage unit for output.

The output information from processing can be sent to a remote host by the file copy service. When the recipient is a Unified System host, the function JFVB-RECV receives an output stream which is checked for structural integrity and placed in the output pool. The output pool data base is formed by the number of magnetic tapes with job output information.

The JFVB functions, including their system and operating descriptions, are components in the Unified System DELTA network software.

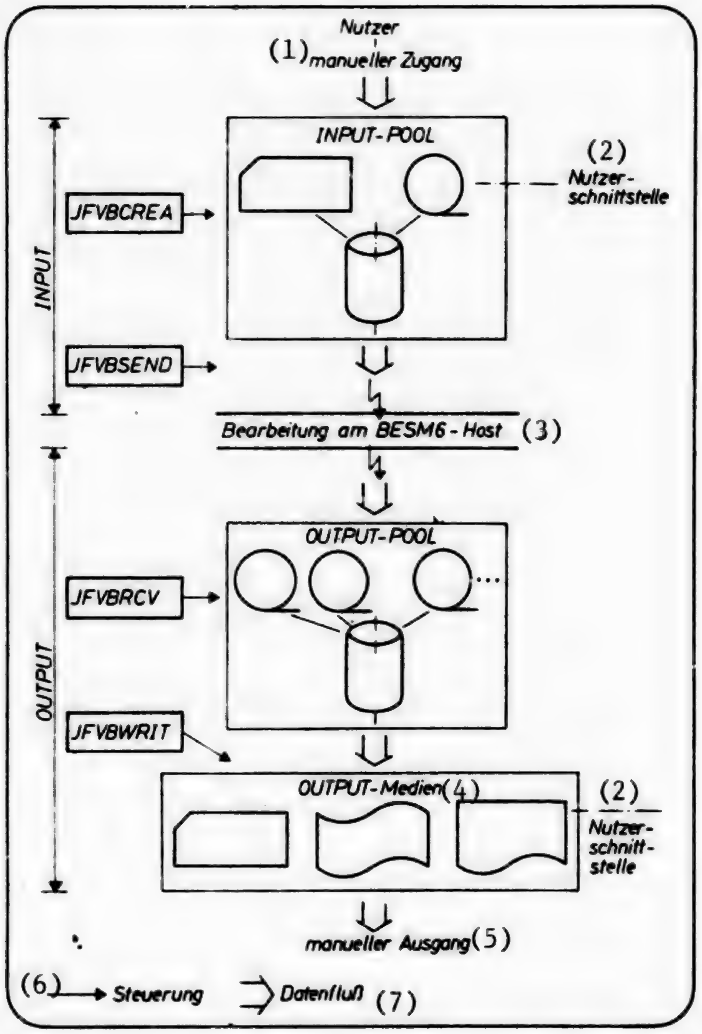


Fig. 2. Remote job processing for BESM-6 jobs (JFVB 12/83)

Key:

1. user manual access
2. user interface
3. processing on BESM-6 host
4. output media
5. manual output
6. control
7. data flow

Applications

We see characteristic application possibilities in the following cases:
--In installations with Unified System host computers which are remote from the BESM-6 host, the BESM-6 network resource can be made available to a user circle in the territory. A number of such network nodes will be set up in the near future. Therefore, it is believed this application will become more important and affects capital investment among other things.

--When Unified System and BESM-6 hosts are nearby, there is the capability of bridging longer downtime periods (e.g. general overhaul) by load balancing.
--The services described can be a considerable part of a relief concept for the BESM-6 system.

Concluding Remarks

Besides the JFVB, there is also the capability of standard processing of Unified System jobs on the DELTA computer network with I/O through a BESM-6 host computer [2].

With these access capabilities in the heterogeneous system, the scope of usage of the DELTA computer network has been considerably expanded. This is the prerequisite for a still more effective integration of DELTA in the strategy for solving problems relevant to the economy.

PHOTO CAPTIONS

1. p 19. Hartmut Anke studied aeronautics at Dresden Technical University from 1955 to 1961. Then he was engaged in practice and research, first in the manufacture and thermodynamics of flow machines and later in information and computer technology. Since 1971, he has been working in the Dresden Technical University computer center primarily in computer network software development and implementation.

2. p 19. Joachim Barthold studied information technology from 1967 to 1971 at the CVUT in Prague and Dresden Technical University. Since 1971, he has been working in the Dresden Technical University computer center in research on computer network software.

3. p 19. Dr. Peter Elste studied applied mechanics. He works on problems of machine dynamics using modern methods of computer technology and is concerned with organization and operation of computer centers. He is a section chief for the BESM-6/YeS 1020 in the Dresden Technical University computer center.

4. p 19. Robotron 4201 packet switching computer with data communication equipment. Photos (4) by Schlechte.

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Computer Network Research

East Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Vol 21 No 5, May 84 pp 20-22

[Article by Prof Dr Helmut Loeffler, Dresden Technical University: "Computer-Aided Analysis and Synthesis of Computer Networks"]

[Text] Research in computer and data networks has been performed in the information processing department of Dresden Technical University since the beginning of the seventies. These activities have resulted in the qualification of the new scientific generation [1-9] and other works [10-16].

While initially the focus was on modeling and behavioral research of computer networks and their components, more and more work was also done on design aids including CAD systems for analysis and synthesis.

The theoretical works on behavioral research and performance evaluation of computer networks and their components are based primarily on the application and problem-oriented expansion of communication traffic theory and significant supplements to it by simulation and systems measuring.

The necessary prerequisites for computer-aided analysis and synthesis of computer networks are the development of a suitable model and the definition of quantities for the behavior or performance evaluation (response time, throughput, degree of loading, etc.). Analysis of computer, data and DFV [data teleprocessing] networks includes among others the analytic, algorithmic and software description and modeling and the development and use of suitable methods of investigation. Among the most important concerns of analysis are
--deeper knowledge, e.g. gaining a deeper insight into the functional relations between performance characteristics and workload or the correlations between structure, resource sharing and load
--research of control strategies
--determination of weak spots
--performance prediction by experiments with models.

The synthesis problem includes primarily
--design of optimal structures according to one or more criteria and
--the best organization of the control process.

Synthesis and analysis are closely intertwined in the planning and design process. Thus, the dimensioning process of computer networks and their components and of data and teleprocessing networks is an obvious candidate for execution with computer and program support. Not only are the design process and the behavioral research implemented thereby at higher level, but also F/E [research and development] time is saved.

Analysis and Synthesis Programs

Table 1 lists a selection of software for studying the behavior and supporting the design of computer, data and teleprocessing networks. Numerous individual programs which can be used autonomously are also available (table 2).

Table 1. Software systems for network analysis and synthesis

Name	Language	Brief Description
RNWANALY	PL/1	used to analyze performance behavior of computer network models under stationary operating conditions
RNWIST	FORTRAN IV	used to analyze performance behavior of computer network models when job load is non-stationary
ASKON	FORTRAN IV	CAD system for cost optimal topological structuring of packet switching networks and for their performance evaluation. ASKON contains some 100 subroutines
DIPAS-DFVS	FORTRAN IV	CAD system for cost optimal topological structuring of teleprocessing networks with tree structure and for their performance evaluation; one or more concentration levels. Contains some 80 subroutines
BNETD	PL/1	used for analysis/performance evaluation of operating networks, particularly with modern solution methods for closed operating networks

Table 2. Selection of individual programs usable autonomously

Name	Language	Brief Description
WIP NEUT BEREB	FORTRAN IV	programs for calculating time dependent state probabilities for M/M/1/s systems; nonstationary incoming stream
VISIT	PL/1	calculation of visit factors in closed operating networks; part of BNETD software system
HWCREC	PL/1	recursive method of Herzog/Woo/Chandy for general service processes; part of BNETD
SERVEX	PL/1	programmed convolution algorithm (1 demand class) after BUZEN; part of BNETD
CHWPRO	PL/1	approximation method for closed operating systems after Herzog/Woo/Chandy; part of BNETD
SACHAP	PL/1	approximation method for central server model after Sauer/Chandy; part of BNETD
MIWAN	PL/1	analysis program for closed operating networks with several user classes based on mean value analysis (Reiser/Lavenberg). MIWAN contains four calculation procedures:
SMVA		single step mean value analysis (exact solution)
CMVA		complete mean value analysis (exact solution)
CORE		approximate solution after Chandy/Neuse based on SMVA
LINZ		approximation method after Chandy/Neuse based on CORE MIWAN is part of BNETD

Only some of the software systems and their applications are discussed in what follows.

The RNWANALY PS [software system] is based on the theory of open Markov operating systems with finite and infinite queue storage. It is suited to computer networks similar to DELTA operating in the batch mode. It can be used to compute these characteristics of computer network models of any structure: response time, standardized stay time, degree of load (e.g. on main computers), throughput, quality factor. Results achieved with this system are presented e.g. in [11, 14].

ASKON handles the following problems:
--determination of cost-effective channel capacities
--calculation of optimal channel flows taking routing into account
--topological design of cost-effective networks which do not exceed a specified mean message stay time
--cost-effective expansion of given structures
--design of networks with k-fold connection (k = 1.2)
--network design with highest possible throughput with given maximal costs.

Fig. 1 shows a network designed with the ASKON PS [software system] [7]. The software system for the operating networks of the Dresden Technical University, BNETD, is suited for analysis of:
--individual operating equipment with general operating time sharing and arrival stream dependent on number of requests
--closed operating networks (product form/nonproduct form; one or more demand classes).

BNETD is based on operating theory (methods for calculating stationary state probabilities), operational and mean value analysis. The analytic methods are based on various computational algorithms and enable studying operating systems by analytic methods [11, 12]. The operating systems represent behavioral models of real systems. The results of the analysis programs are stationary state probabilities and state values derived from them (mean number of requests resident, mean stay time, throughput, load).

As an expanded service, there is available for each analytic method a standard application program which reads in the variable configuration and load parameters and outputs the results. The performance of different algorithms can be compared. The basic algorithms (BUZEN, MVA) are the basis for the modified (special) method with a non-product form solution.

With the framework of [10], the Unified System transport station in the DELTA computer network was modeled; the BNETD subroutine MIWAN with expanded mean value analysis was used to study and parameterize it. In close cooperation with the Dresden Technical University computer center, this provided valuable knowledge on the operating behavior of the DELTA transport components.

The dialog-oriented program system DIPAS-DPVS was developed to design and optimize data teleprocessing networks with several concentrator levels and terminal systems of computer networks and at the same time calculate their

performance by quality criteria. Therefore, the DIPAS-DPVS system contains analysis and synthesis components.

Implemented in the DIPAS-DPVS CAD system are:
--structuring methods from the known specialized literature
--a newer, more efficient structuring algorithm [6, 9]
--operating theory methods for analysis and performance evaluation of cost-optimally structured systems. In doing so, infinite and finite queue storage is considered. Response times, quality factors, resource loading, maximal throughput (performance capability) are calculated as a function of the load.

The software systems and individual programs are available for related use. Those interested should write directly to the author.

PHOTO CAPTIONS

1. p 21. Professor Helmut Loeffler studied electrical and nuclear engineering at the Dresden Engineering College from 1952 to 1958. In 1965, he obtained his doctorate in engineering in the electrical engineering school at Dresden Technical University with a theme on electrical measuring of non-electrical quantities. In 1971, he received his second doctorate in the data processing school at Dresden Technical University. Since the beginning of the seventies, he has been engaged exclusively in computer engineering and information processing. In 1974, he was appointed university professor of information acquisition and communication. Since 1977, he has headed the scientific section of computer systems in the department of information processing. His specialties are: modeling and behavioral research of computer, data and teleprocessing networks; communication traffic theory; computer connections; data communication.

2. p 22. Fig. 1. Network when TYMAX equals 0.1 second

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Educational Uses

East Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Vol 21 No 5, May 84 pp 23-24

[Article by Prof Dr Helmut Loeffler, Dr Klaus Irmscher, Dresden Technical University: "Computer Networks as a Subject and Means of Education at the Dresden Technical University"]

[Text] The application and further development of modern information technologies require long-term training and education of specialists in engineering and technology of computer networks. At the Dresden Technical University, students have been educated in modern communication and computer network technology for more than 10 years in the information processing department. It is part of the curriculum for basic studies in information processing approved by the GDR Ministry for University and Technical School Affairs.

Educational Scope and Content

Imparting knowledge and qualification in data communication and the theory and practice of computer networks occurs in the fourth year of study. This includes 15 hours of lectures, 15 hours of exercises and 15 hours of practice for all students of information processing. Students majoring in computer systems also receive education in depth in this area and in operating systems in the fourth year. This includes 60 hours within a specialized seminar. in the school lecture "Local Networks and Computer-Aided Communications Technologies," students can acquire expanded knowledge. At the end of the ninth semester, a number of students defend theses related to computer networks.

The obligatory curriculum includes these main points:
--data networks: structures and functional components; communication services and protocols in circuit and packet switching networks; application of message traffic theory to computing typical network parameters (stay time, throughput)
--hardware and software for remote data processing systems
--computer network systems: logical and physical structures of computer linking; multilevel structure of communication services; OSI reference model; communication protocols; computer networks implemented, particularly the GDR DELTA computer network, features of local networks.

The practical course now includes multi microcomputer linking and work with an access system typical to DELTA. Following is a brief description of the part of the practical course relevant to computer networks.

Practical Course in Computer Networks

As is generally known, the user accesses the DELTA computer network through the terminal system. The interface between the computer network kernel and the terminal system is implemented by the terminal interface processor (TIP). In the information processing department of Dresden Technical University, in

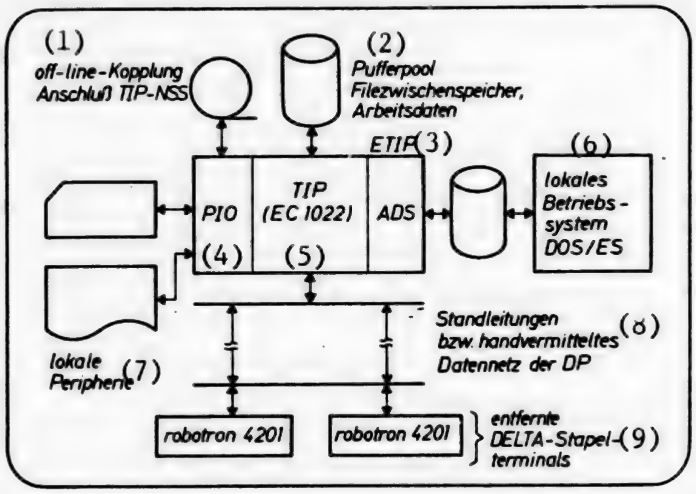

Fig. 1. Network oriented terminal system used in the practical course

Key:

1. off-line link, TIP-NSS link
2. buffer pool, file intermediate storage, work data
3. ETIP [expanded terminal interface processor]
4. PIO [physical I/O system]
5. (YeS 1022) TIP
6. local YeS/DOS operating system
7. local peripherals
8. dedicated lines or dial-up ~~German~~ Post data network
9. remote DELTA batch terminals

close cooperation with the university computer center and in cooperation with the GDR Academy of Sciences, a TIP was developed based on the Unified System DOS operating system [1, 2, 3]. Students working for their diplomas played a major part in the development of this system (e.g. [4, 5, 6, 7]). The TIP has been used in education for four years. It was expanded to also allow independent terminal operation of the link to the computer network kernel [3, 8]. An overview of the network oriented terminal system used in the practical course is shown in fig. 1. The expanded TIP, ETIP, has the special subprocesses PIO and ADS besides the TIP process concept [2]. The PIO (physical I/O system) performs, among others, the following tasks:
--link and drive of local peripherals of the TIP computer with local user interfaces (analog of user interface to remote terminal)
--separation of certain jobs for processing independent of the computer network.

The ADS subprocess enables processing of Unified System DOS jobs. When jobs for the Unified System DOS are identified in the input stream, they are separated and transferred through the ADS process to the local DOS operating system. After processing, they are sent through the TIP to the output terminal specified in the job. Thus, the ADS subprocess works like a main computer for Unified System DOS jobs.

The main concerns of the practical course are:
--to deepen knowledge of a DELTA terminal subsystem through the functions and protocol hierarchy
--to practice operation and use of the terminal system
--to evaluate system operation.

In the practical course, the students solve the following problems among others:
--log on through dedicated lines and the dial-up German Post data network
--loading of the program system and operation of the remote DELTA terminal; terminal switch on/off; user file I/O (with processing under the Unified System DOS operating system
--determine transfer times of I/O files as a function of file length and total stay time in the case of direct processing.
--representation of protocol flow of selected levels and evaluation of system management.

PHOTO CAPTION

1. p 23. Dr. Klaus Irmscher was born in Chemnitz. From 1956 to 1961, he studied in the department of mechanical engineering at Dresden Technical College. After earning his diploma, he worked as a scientific associate at Dresden Technical University in the field of engineering mechanics (theory of elasticity, outer shell design). In 1968, he received his doctorate in engineering in the school of mechanical engineering, Dresden Technical University, with a work on the theory of thin-walled shells. From 1970 to 1974, he was engaged in practical applications in an industrial computer center (efforts on operating systems, systems programming and remote data processing). Since 1974, he has been a senior scientific associate in the information processing department, Dresden Technical University. His specialties are systems programming, operating systems, remote data processing, computer networks and methods and techniques of performance evaluation of computer systems.

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NEW COMPUTER DEVELOPMENTS DESCRIBED

Mero-60 Minicomputer Exports

Warsaw POLISH ECONOMIC NEWS in English 16 Jul 84 pp 8-9

[Text] In the field of computer equipment, exported by Polish Foreign Trade Enterprise Metronex to the Soviet Union, great acceptance has been gained by mini-computer system Mera-60 produced by the Scientific-Production Center of Control Systems Meraster in Katowice.

Mera-60 is a set of implement and program modules enabling a user to create various systems according to his needs. Basic element is the Soviet micro-processor Elektronika-60, matching functionally the PDP 11 03 one of Digital Equipment Corporation. Mera-60 system allows using external store, standard peripheral equipment and devices equipped with commonly used interface.

According to the needs and attached devices Mera-60 can be applied in:
- automatization of laboratory works
- scientific and technical calculations
- preparation and local data processing
- automatization of small enterprise management
- control of selected manufacturing process.

Prototype lot (10 pieces) produced in 1979 found suitable application in laboratories of the United Institute of Nuclear Research in Dubna. Efficiency of Mera-60 and ability to co-operate with other mini-computer systems of renowned firms aroused interest in other scientific centers of the Soviet Union. In consequence, this system was bought by the majority of research institutes of the Academy of Science of the U.S.S.R. and Engineering Colleges. First contracts signed and concluded in 1980 provided for the delivery of 60 Mera-60 systems. Since that time export of this digital computer has been growing yearly by approx. 100 pieces. It is anticipated that this year about 500 computers of this type will be delivered to the U.S.S.R. It is estimated that Mera-60 is used in 120 scientific centers throughout the U.S.S.R. During this year's Poznan Fair further contracts are expected to be signed on delivery of Polish computers to the Soviet Union. (bb)

ROSA Minicomputer

Warsaw POLISH TECHNICAL REVIEW in English No 4, Apr 83 pp 9-11

[Article by Lech Szyngweksli]

[Text] **Production of electronic components for the microprocessor circuit 8080 developed by the American firm of INTEL was started in mid-1970s in Poland. The microcomputer ROSA 7741 S, based on these circuits, was built at the Electronic Equipment Works UNITRA-UNIMA, Warsaw. This microcomputer was used, among other things, for cooperation with the MST modular testing system assemblies[1]).**

In order to impart system features to the MST assemblies it is essential to equip them with an intelligent device acting as a controller.

The main tasks of the controller are as follows: adjustment of individual pieces of equipment, monitoring of the circulation of information in the system, data processing (e.g. results of measurements) and data editing. Additional requirements to be met by controllers are: small dimensions, modular design and, above all, rapid operation via the IEC interface. All these requirements are met by the ROSA 7751 S microcomputer (an abbreviation of Rationally Organized System Administrator). A general view of the microcomputer is shown in Fig. 1, its block diagram being presented in Fig. 2. The LSI components 8080A, 8824, 8228, 8253, 8214, 8216 and 8212 have been incorporated in the design.

The microcomputer control system is based on the INTEL 8080A microprocessor, so that the basic programming language is constituted by the symbolic language of that particular microprocessor. The ROSA microcomputer has a maximum memory capacity of 52 Kbytes divided into packages. The number of storage units in a package depends on the type of components used. Package interchangeability is possible, and each package may constitute a RAM or EPROM storage. The address space allotted for the store is 68 kB, including 36 kB of direct-address store and 32 kB of elocatable store (one in which the 4 oldest bits of the 16-bit address are taken from a special, programmable register). Storage relocatability allows the loading and execution of the same programs in various relocatable store packages.

Direct contact with the operator is rendered possible by the operating console and display. The operating console contains a universal keyboard and keys controlling the operation of the microcomputer. Each of the 128 keys may be assigned to an 8-bit code selected by the user. This was achieved using the EPROM store: 2704, 2708, or 2416. The display is constituted by an assembly of 16 display units. The display of a 256-character text has been program-organized, the following operations being possible on the displayed text: shift to the left and right, clearing, deletion and insertion of individual characters.

The monitor display being currently developed is expected to extend considerably the display possibilities. The ROSA minicomputer may be equipped with 4 or less channels hooked up to the IEC interface. Each of the channels is provided with a control sytem, independent of the central processing unit. A 1 kB buffer store allows the attainment of a maximum interface transmission rate.

The PK-1 cassette store, made by MERA-MAT, Warsaw, has been built-in into the ROSA microcomputer. The cassette store channel control system, similarly to the IEC channel, operates independently of the central processing unit. This channel incorporates a 256 byte buffer store. Organization of the recording and reading allows for data transmission at any place of the tape.

1) See PTR No 1/80

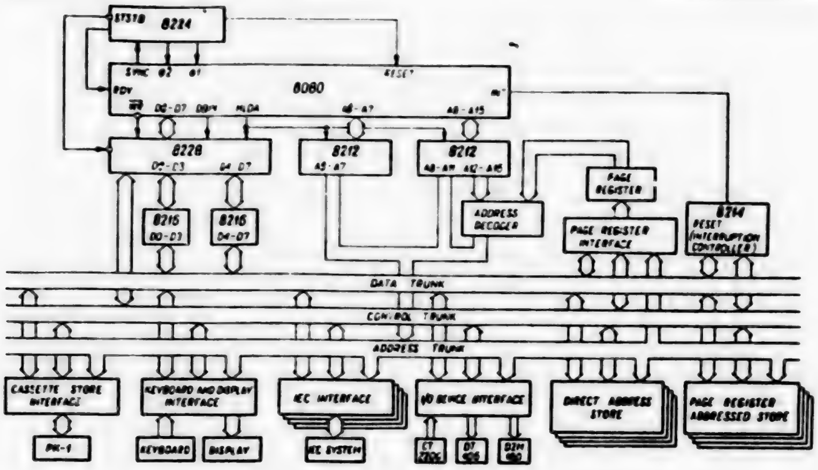

Fig. 2. Block diagram of the ROSA microcomputer

The ROSA microcomputer is provided with an input channel controlling the operation of the following peripherals: the DZM-180 dot-matrix printer, the CT-2200 paper tape reader and the DT-105 paper tape punch. The interruption system is based on the 8214 interruption controller. One of the interruptions constitutes the logical sum of eight independent interruptions due to the peripheral devices. Two of the interruptions are the so-called [illegible]-clock interruptions made once every [illegible]s and 1s.

The ROSA microcomputer is provided with the following programs wired in the EPROM-type fixed store: Bootstrap, Monitor, Editor, Assembler, Floating-point Arithmetic. Bootstrap occupies 512 bytes of the store placed on a single functional package instead of on memory packages. It starts the microcomputer operation after the power supply has been switched on, which makes it possible to modify the storage and to start-up the programs stored in them when interruptions are deadlocked.

The monitor program plays the role of an operating system and takes up 5.5 kB of fixed store. The monitor program controls the interruptions, organizes the projection and editing of texts on displays, enables the observation and modifications of storage and microprocessor registers, starts-up the execution of programs with the possibility of setting program traps, executes commands and operational subroutines on the keyboard, display, cassette memory, reader, punch and printer. The edit routine makes possible the writing and correction of any texts, including the programs written in the symbolic language for the INTEL 8080 microprocessor. The edit routine occupies 2 kB of the fixed store. The volume of the edited text is limited only by the number of RAM stores. The texts edited by the edit program may be input or output via the keyboard, display, paper tape reader, paper tade punch and cassette store. The assembler program translates into the object program the source program written in the symbolic language for the INTEL 8080 microprocessor. The object program is stored directly in the ROSA microcomputer store or output in the standard 16-bit format as punched paper tape.

The assembler occupies 7 kB of the fixed store. The symbolic language syntax conforms to the description provided by the firm of INTEL. The number of RAM stores is the factor limiting the number of symbols and the size of the assembled program. Floating-point arithmetic is constituted by a package of programs performing such operations as addition, subtraction, multiplication, division, and square root extraction.

Special equipment is necessary for starting microcomputer operation, and therefore the CDU 7410 (controller development unit) device has been designed

and implemented in production. The controller development unit is designed for the development of systems and software of microprocessor systems built basing on components of the INTEL 8080 family. A general view of the CDU 7410 unit is given in Fig. 3.

The CDU 7410 unit makes possible:
- the observation of system trunk conditions (address, data and control trunks),
- the static control of system trunks,
- the realization of four variants of program halts at a required address: in the interrupted condition (in the RST interruption (reset) statement fetching machine cycle), in the FETCH machine cycle (instruction code fetching cycle), in a successive machine cycle,
- program modification (possibility of deadlocking the system memory units and controlling the data trunk),
- the deadlocking of time-clock system resets (interruptions),
- the reading and modification of the content of microprocessor internal registers.

The CDU 7410 unit is connected with the microprocessor system by means of a unified-design diagnostic interface.

A fixed store programmer is another piece of equipment indispensable for starting-up microprocessor systems. The UNITRA-UNIMA Works have already developed the PMC 7411 fixed store programmer which may be connected with any microprocessor system, such as e.g. the ROSA microcomputer, using the same standard interface as that applied for the CDU 7410 unit. Operation of the PMC 7411 is controlled by a program realized by the microprocessor system.

The PMC 7411 unit makes possible the programming of such stores as:
- EPROM: 2716, 2708, 2704 (according to programming procedures of the firm of INTEL),
- PROM: MH 74188 (according to programming procedures of the firm of TEXAS INSTRUMENTS).

In the case of the ROSA microcomputer, the fixed stores may be programmed using data input from the keyboard, punched paper tape, magnetic tape, or directly from the ROSA memory.

Various versions of the ROSA microcomputers are available. One of these is designed for the start-up of the software and equipment based on the INTEL 8080 microprocessor. This particular version does not have IEC channels, but its store has been increased by 16 kB. The BASIC programming language interpreter is now being developed.

Computerized Biocybernetic Speech Recognition

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[Article by Ryszard Tadeusiewicz]

[Text] The problem of automatic recognition of human speech has not yet been solved satisfactorily for any language. A solution of that problem will make possible the further enhancement of man's ability to communicate with various technical devices (computers, in particular) while ensuring higher speed and reliability of operation of the man-machine system thanks to the elimination of one of the "weaker links of the information chain". Information communicated by means of speech sets free the hands and legs of the operator from performing individual control functions, and do not tie him down to any fixed working station while enabling efficient operation in darkness, in overload or weightlessness conditions, under severe stresses, etc.

In order to master the automatic speech recognition technique it is indispensable to solve the following five problems:

- entering of the speech signal into the computer,
- signal segmentation into elements to be recognized,
- selection and automatic determination of characteristic features of individual elements necessary to recognize them,
- recognition of speech signal elements,
- integration of sequences of recognized elements into recognized statements.

The hybrid speech analysis and recognition system developed at the Department of Biocybernetics of the Institute of Automation, Systems Engineering and Telecommunication of the Academy of Mines and Metallurgy (AGH), Cracow, provides a satisfactory solution of the above listed indispensable stages.

Entering speech into the digital computer store

It is necessary to select the form of signal conversion when entering the speech signal. Analogue-to-digital conversion is by far the simplest way of entering the samples, amplitude-quantitated signal time sequence. Most of signals analyzing systems using digital computers operate on that principle. This approach is rendered difficult when recognizing human speech elements, as the incoming information stream represented by the speech signal time sequence may be estimated at 2.10^5 bits/s. A standard, accessible computer store is only capable of recording a few seconds of signal duration time, which is insufficient to deal with most typical spoken statements. In the AGH-developed system, the speech signal is subjected to band spectrum analysis prior to being fed to the computer. 96 band filters covering the range of 125···12 kHz and sampled at 9 ms intervals with an accuracy of up to 1.6 dB are used for that purpose. The computer is consequently fed with a dynamic spectrum of the signal with a capacity of 5×10^4 bits/s.

An additional advantage resulting from the preliminary processing of the signal prior to its being fed into the computer, consists in the computer store holding a spectral representation of the signal which does not have to be calculated (e.g. using the FFT algorithm).

Segmentation of the continuous speech signal

Choice of elements to be recognized depends inherently on the segmentation methods employed. In view of the phonetic requirements it is advisable to use phonemes as the recognizable speech elements. The number of phonemes is limited (in the Polish language there are about 40 phonemes), and their characteristics to be recognized are well defined. The main difficulty lies, however, in the division of the speech signals into phone-

mes. In reality, this is a continuous process in wich the time limits imposed on the phonemes may be determined by subjective methods (by an experienced phonetician), these limits being extremely difficult to determine automatically. In numerous solutions, including commercially available speech recognition equipment, the recognition of complete words is employed. That approach, however, limits the vocabulary of recognizable word forms, a severe drawback felt especially acutely in languages with a strongly developed inflexion.

The AGH system is based on a compromise solution, whereby the speech signal fed into the computer is divided on entry into equal time segments characterized by their own instantaneous spectra. Consequently, it is the instantaneous spectra that are the object being recognized, a single phenome corresponding to several to a few score instantaneous spectra, and a word being equivalent to several score or a few hundred spectra. A certain classification of these spectra is possible by applying criteria relating to inherent similarities between the various spectra and using cluster analysis techniques. The thus obtained similarity classes constitute the various patterns of the individual instantaneous spectra fed into the digital computer. The statement being analyzed is made up of such patterns.

Characteristics of spectra providing a basis for pattern recognition

Pattern recognition approaches and techniques are based on the assumption that the objects being recognized, in our case the speech signal instantaneous spectra, are represented by points in a certain abstract space of characteristic features. This space is determined by defining certain measurable parameters of the objects, termed characteristic pattern features. There are many features that may be used for the recognition of speech signals, and the AGH-developed system is based on a five-dimensional space of features determined by the calculated values of the first three spectral formants and the first two spectral moments. Although the detection and computation of spectral moments does not present any significant difficulties, the computer-based determination of spectrum formants is an intricate problem owing to the necessity of detecting and describing the general features of the spectrum while reducing to a minimum the influence of its microstructure. A special algorithm, named WRMP, was developed during the studies on speech recognition to determine the values of formant frequencies. The WRMP algorithm is not unduly sensitive to minor irregularities of the spectra.

Recognition of instantaneous spectra

As a result of spectra cluster analysis, about 100 classes of instantaneous spectra similarities providing individual recognition patterns have been drawn up. The individual patterns correspond, among other things, to the characteristic shapes of instantaneous spectra of individual phonemes, and also to the dynamic transition states between the particular phonemes (called transients). This is significant in that a wide class of phonemes is recognized mainly on the basis of characteristic transients of the vicinal vowels, while the spectra corresponding to phonemes themselves do not possess any characteristic features that might lead to unequivocal identification. Obviously, for many phonemes there exist various variants of spectra, recognizable at this stage as different „patterns", depending on the context and the individual features of the voice of the speaking person. Inaccurate recognition is also permissible (indication of several probable classes of phonemes) along with even erroneous recognition. Basing on the fact that a single phoneme is composed in this system of several or a few score recognitions, and that every arrangement of phonemes is equally probable from the linguistic point of view, the erroneous recognitions may be corrected in the successive, higher stage of analysis.

Relevant research work was performed in order to establish the optimum recognition method. As far as recognition efficiency is concerned, the nearest neighbour method (the so-called NN algorithm) was found to give good results. The NN method is, however, computationally inconvenient as it entails operations on large sets of data representing the so-called teaching series, and involves the application of time-consuming computational procedures for obtaining measures of distance in multi-dimensional spaces. In view of this, the statistical approach of Bayes was selected as the optimum recognition method, a suitable choice of the

probability density distribution function being made for individual classes of the instantaneous spectra.

Integration of elementary recognition sequences

As a result of recognizing spectra using the above described methods, a number of elementary recognitions are obtained. These are subsequently integrated at further stages of analysis. The integration process involves a successive verification and reduction of the chain of elementary recognitions with a view to establish the final recognition of the statement being analyzed. The integration process is based on a wide utilization of the context peculiarities both on the level of individual words and on that of relationships between words that occur in a given sentence. A vocabulary of words being recognized is of assistance at this stage of integration. This vocabulary is compled basing on the expected course of conversation, and contains so-called key words playing a significant role in the semantic identification of the substance of the statement. Other words, missing from the vocabulary, may be ignored at that stage since, even in the case of their being identified correctly from the acoustic and phonetic points of view, it is impossible to utilize their semantic value. A simple syntax analyzer, indispensable owing to the inflexional nature of the Polish language, is used as an auxiliary device.

The correctness of recognition featured by the AGH-developed system at the instantaneous spectra identification stage is in the limits of 68% to 97 5%, which corresponds to about 98.3% of correct recognitions of words when using the above discussed context analysis approach. For a single spectrum, the recognition time is equal to 7.3 ms (spectrum duration – 9 ms). However, the time required to perform all auxiliary functions (computation of characteristic features, context analysis, etc.) is such that real time recognition is unattainable (times ranging from 250% to 380% of statement duration are employed). The system operates on a single male voice in conditions of careful articulation and with elimination of interference. 60 K of the storage capacity of the CDC Cyber-72 computer are required for the realization of the AGH-developed system.

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